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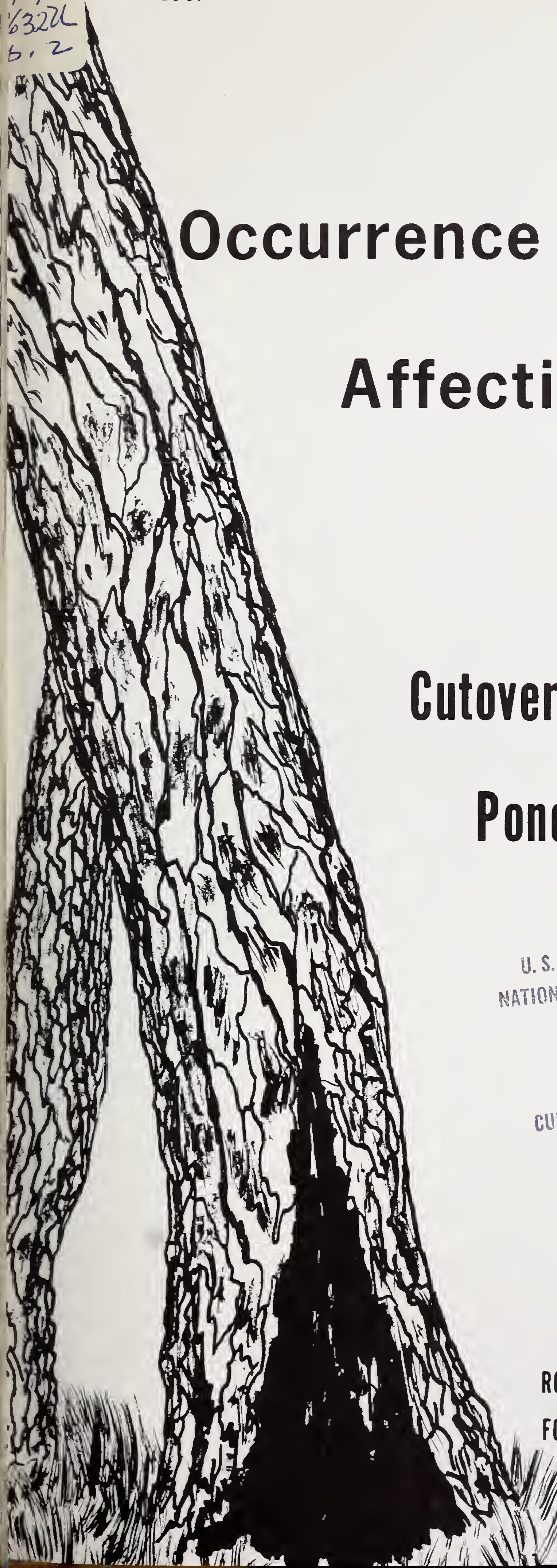

Occurrence of Stem Features Affecting Quality in Cutover Southwestern Ponderosa Pine

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ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION
FOREST SERVICE U.S. DEPARTMENT OF AGRICULTURE

The basic inventory method employed in this study, and analysis of typical stem-quality information obtained, are discussed in detail in U.S. Forest Service Research Paper RM-15, "A Method of Evaluating Multiproduct Potential in Standing Timber," available from the Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado 80521.

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by

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Better information is needed about physical stem characteristics that affect the quality of standing timber. Stem quality for most primary products is largely determined by the same few stem features--features such as sweep, crook, fork, scar, and aggregate knot or limbing characteristics. Given sufficient information about the occurrence and severity of these characteristics, we can readily estimate suitability of the timber for a wide variety of products. Concurrently, we need adequate methods of observing, measuring, and expressing the quality of standing timber.

This paper reports the results of a study designed to determine the frequency of occurrence of particular stem-quality features in cutover ponderosa pine stands (Pinus ponderosa Laws.). Specific objectives of the study were to (1) test the application of recently developed methods of timber-quality inventory and classification; and (2) determine the current occurrence and severity of stem-quality characteristics in cutover stands. The quality information developed provides a basis for appraising stand potential for a variety of products. It also provides a basis from which to determine stand-quality changes over time. The methods employed could be applied in other timber types to provide similar timber-quality information.

Basic Timber Quality Information Needed

Patterns of forest utilization in the Southwest are changing. The industry, historically oriented toward lumber production alone, is adopting new products, new conversion methods, and more diversified operations. Because the "sawtimber" tree of a decade ago may now be actively considered for products other than lumber, broader concepts of timber quality are required. The character of the timber is also changing as high-quality, old-growth timber is removed and harvesting operations re-enter previously logged stands.

The bulk of the future regional timber resource is contained in stands of cutover ponderosa pine (fig. 1). Interest in product diversification and increasing dependence

Figure 1.--Cutover stands of mature ponderosa pine, such as the one pictured, contain a large proportion of the regional timber resource.

upon cutover stands both emphasize the need for better knowledge of these stands. They must be described in terms of suitability for a range of potential primary products. Determining the occurrence of stem-quality features related to suitability and/or yield for particular products is a necessary initial step.

Cutover Ponderosa Pine Area Studied

Sawtimber has been harvested one or more times from much of the ponderosa pine type in the Southwest, leaving extensive cutover stands. Previous harvest cuts have generally removed from 35 to 60 percent of the merchantable sawtimber volume. The study was concerned with the stem quality of the sawtimber currently stocking these cutover stands.

The area studied (fig. 2) consists of 11 pilot watersheds encompassing approximately 9,000 acres on the Beaver Creek Watershed Evaluation Project in north-central Arizona (Worley 1965).[2] The pine stands covering the area are uneven-aged, with much of the stand arranged in even-aged groups. Site index for the area ranges from 50 to 70 feet at 100 years of age (Meyer 1938). Gambel oak (Quercus gambelii Nutt.) and alligator juniper (Juniperus deppeana Steud.) occur as intermingling minor species. Timber was last harvested from the area during the period 1943-50, when half of the merchantable volume of sawtimber was removed. Current sawtimber volume on the area averages 4,000 board feet per acre (Myers 1963).

Measuring Stem Quality Characteristics

Field data were obtained during the development of a method of observing and recording visual stem-quality features in standing timber (Ffolliott and Barger 1965). The inventory method was designed to provide for systematic observation and measurement of all major visual stem characteristics related to product quality. When coupled with valid sampling techniques, the method allows computation of the frequency of occurrence of observed features.

Point-sampling techniques were used to select sample trees. A total of 1,403 permanent sample points were located on the pilot watersheds by means of a systematic sampling design with multiple random starts (Freese 1962, Shiue 1960). Ponderosa pine trees 7.0 inches and larger in diameter were selected at each sample point with an angle gage corresponding to a basal area factor of 25. A total of 3,799 sample trees were so selected for observation and measurement. For each sample tree, visual stem-quality features that might affect product quality and yield were recorded. The stem-quality features specifically observed and measured included (1) stem form features of sweep, crook, fork, and lean; (2) injury or scar features; and (3) log knot configurations in sawtimber stems. The procedure for measuring, classifying, and recording each of these stem features is outlined below:

I. Stem form features:

A. Sweep, recorded as
1. Minor--less than 1/3 d.b.h. deviation in straightness.
2. Major--1/3 d.b.h. or more deviation in straightness.

B. Crook, recorded as
1. Minor--less than 1/2 mean diameter deviation in straightness within a section 5 feet or less in length.
2. Major--1/2 mean diameter or more deviation in straightness within a section 5 feet or less in length.
3. Location of crook in stem, to nearest half log.

C. Lean, recorded as degree of lean, to nearest 5°.

D. Fork, recorded as location of fork in stem, to nearest half log.

[2] *Names and dates in parentheses refer to Literature Cited, p. 11.*

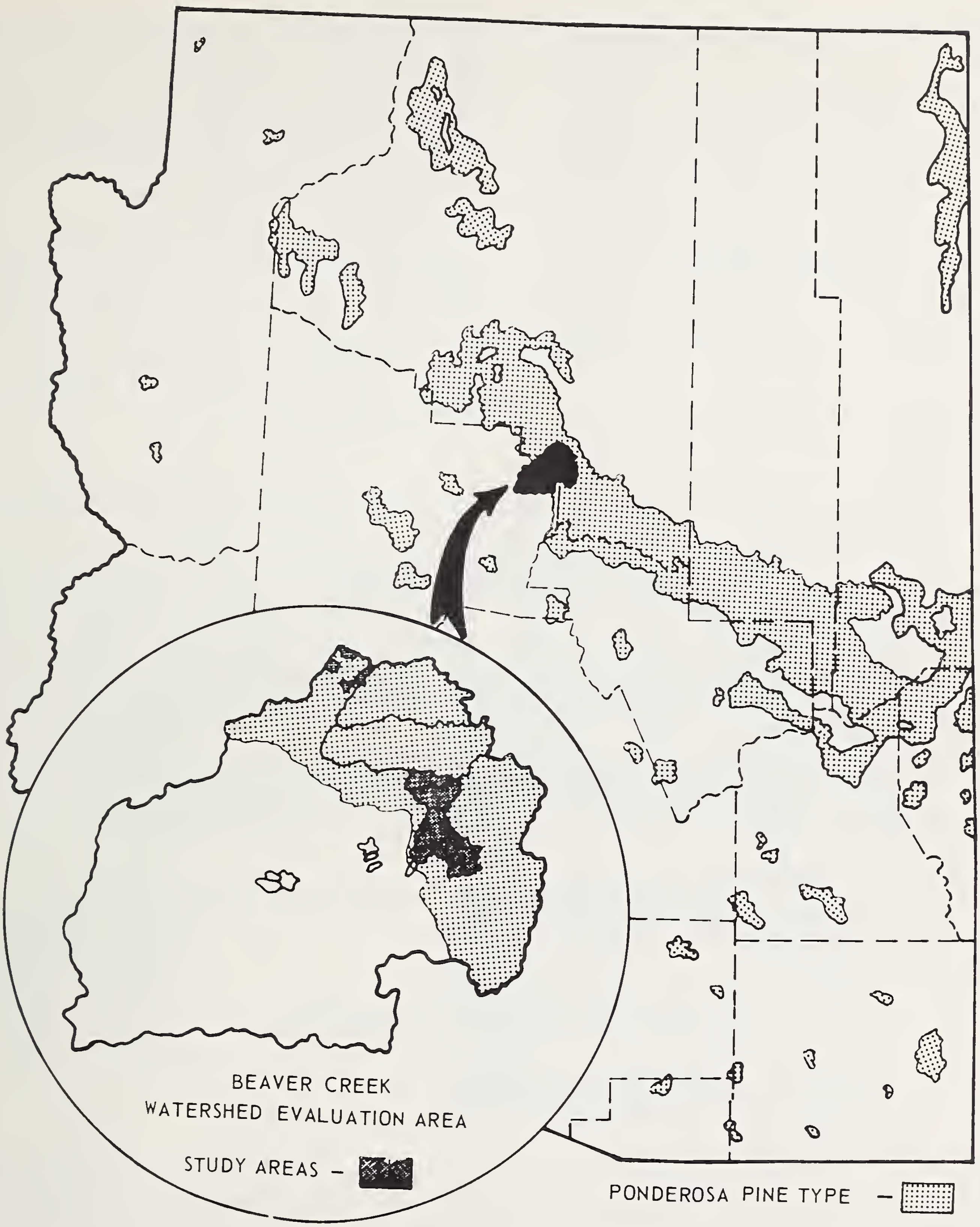

Figure 2.--The study areas, part of the Beaver Creek Watershed Evaluation Project, are located within the major belt of ponderosa pine timber extending across Arizona.

II. Injury features:

A. Basal scar, recorded as
   1. Minor--less than 1/4 bole circumference affected.
   2. Major--1/4 or more of bole circumference affected.

B. Lightning scar, recorded as
   1. Minor--less than 1/4 bole circumference affected.
   2. Major--1/4 or more of bole circumference affected.

C. Damaged top, recorded as
   1. Dead top.
   2. Broken top.

III. Log knot configurations:

Both occurrence and distribution of log knots are important indicators of product potential. Accordingly, the knot features of all sample trees 11.0 inches and larger in diameter were characterized in two ways: (1) presence of clear surface area in the first two 16-foot logs; and (2) number and size of knots in first 16-foot log. Specific information recorded includes:

A. Clear 8-foot faces (panels 8 feet by 1/4 bole circumference), recorded by position within each succeeding 8-foot stem section, to 32 feet height or to a 10-inch top diameter.

B. Log knots and knot indicators, recorded as
   1. Number of knots in each full face of first 16-foot log.
   2. Diameter of largest knot in each log face, to nearest inch.
   3. Condition of largest knot in each log face (live or dead).

Stem-quality information for all sample trees on the study area was aggregated by tree diameter class. A base stand table representative of the study area was developed from data for all inventoried trees. Separate stand tables were then developed for trees exhibiting each observed quality characteristic. These tables, when expressed as a proportion of the base stand table, indicated the frequency of occurrence of the represented feature. A frequency-of-occurrence table was thus constructed for each observed quality feature, which indicated the frequency of occurrence within each size class of trees and within the stand as a whole.

Log knots and clear surface area are usually common to all stems; consequently, the stand table method of expressing occurrence is not adequate. The occurrence of these features was expressed instead as proportion of stems having specified knot or clear face characteristics.

Occurrence of Stem Quality Features

The inventory documented the occurrence and severity of stem characteristics related to quality in the cutover stands sampled. Aggregate occurrence data provided a basis for calculating frequency with which each characteristic occurs within size classes and within the stand. To facilitate presentation, the frequency tables for individual stem features have been converted to bar graphs, and tree diameter classes have been grouped into these four major size classes:

Size class	Diameter range	Sample trees
	(Inches)	(Number)
Poles	7.0-10.9	1,436
Small sawtimber	11.0-16.9	1,150
Medium sawtimber	17.0-22.9	559
Large sawtimber	23.0 +	634

Stem Form Features

Irregular form features in the merchantable stems of standing timber substantially influence product potential. Form is more important than volume in determining the value of stands for some products. Sweep, crook, lean, and fork are particularly important (Pearson 1950). Sweep and crook may substantially lower the net volume in a merchantable stem, and may be inadmissible defects in such products as commercial poles. Lean, a common characteristic of ponderosa pine, is an important form feature because of

the associated formation of compression wood (Pillow and Luxford 1937). Forking in the merchantable stem limits the length and net volume of products obtainable. The distorted grain accompanying a fork may also lower the quality of adjacent material (Jackson 1962).

The occurrence of sweep, crook, lean, and fork in ponderosa pine trees on the study area is illustrated in figures 3, 4, 5, and 6, respectively.

Injury Features

Mechanical injuries such as scars can reduce substantially the usable volume of standing timber. Injury scars are also commonly

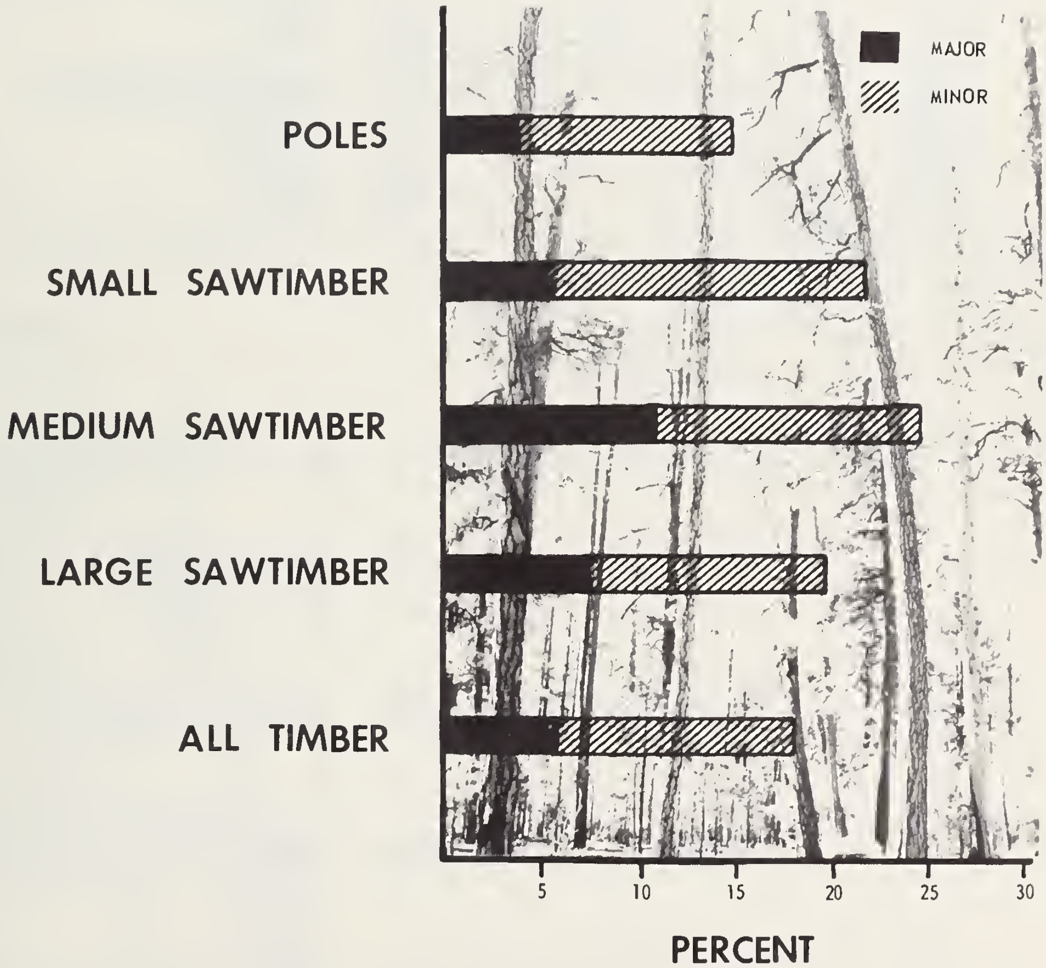

Figure 3.--Percentage of sample trees in four size classes with major or minor sweep (more or less than 1/3 d.b.h. deviation in straightness).

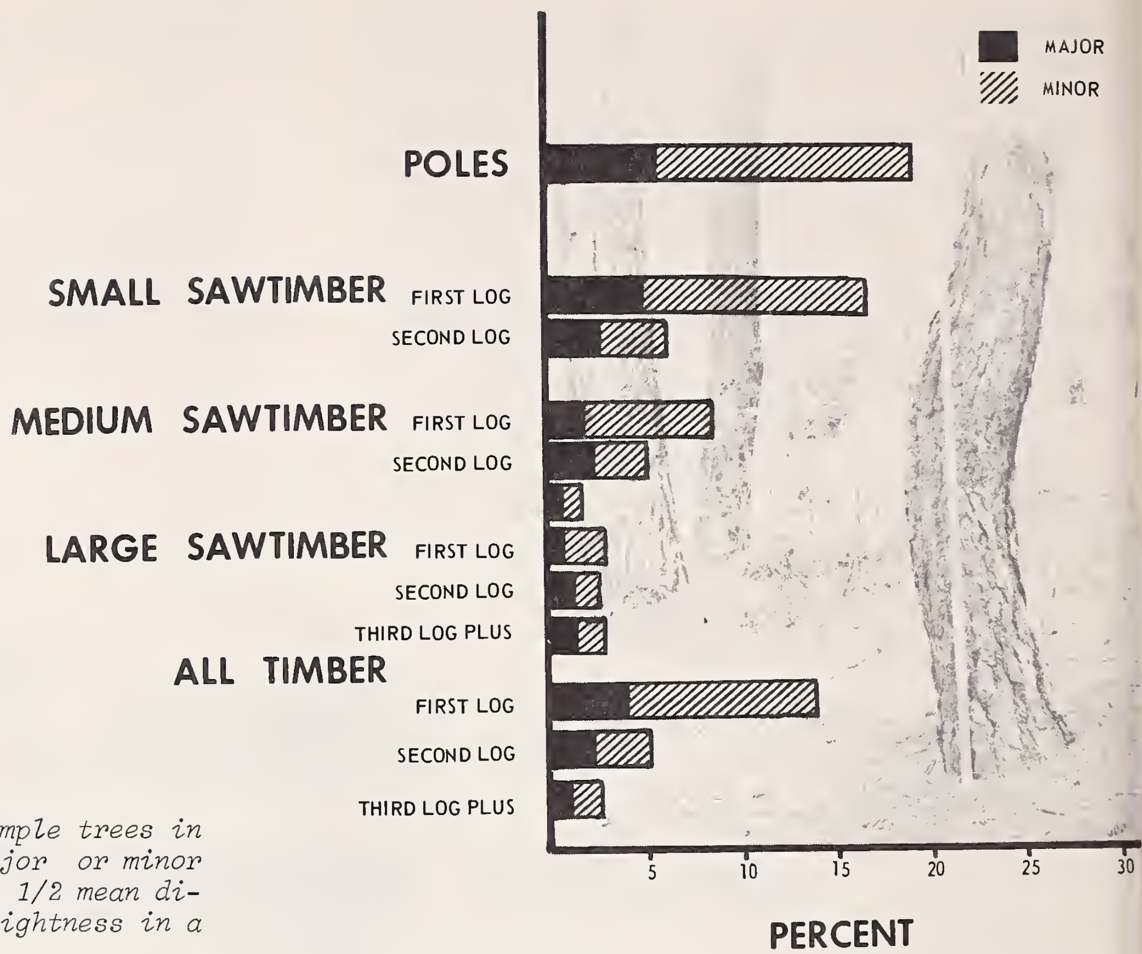

Figure 4.--Percentage of sample trees in four size classes with major or minor crook (more or less than 1/2 mean diameter deviation in straightness in a 5-foot section).

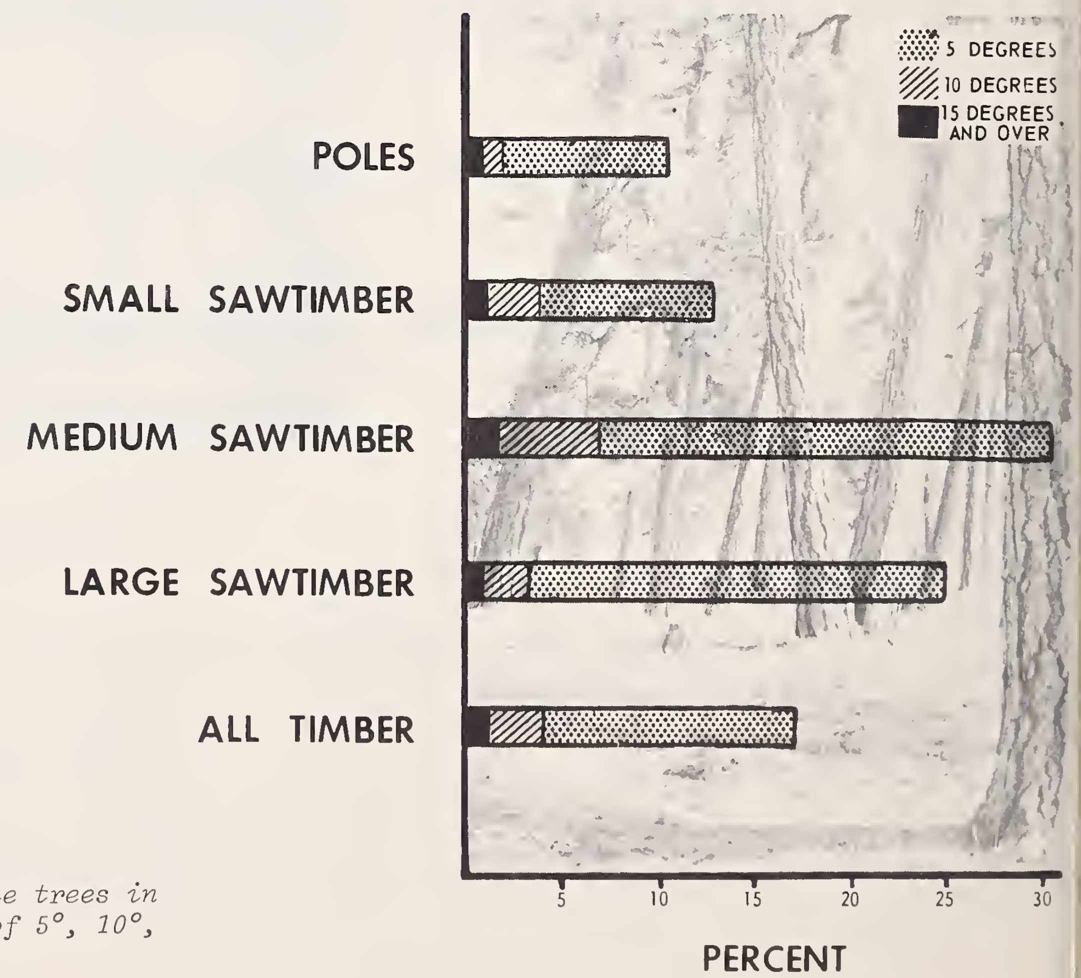

Figure 5.--Percentage of sample trees in four size classes with lean of 5°, 10°, or 15° or more.

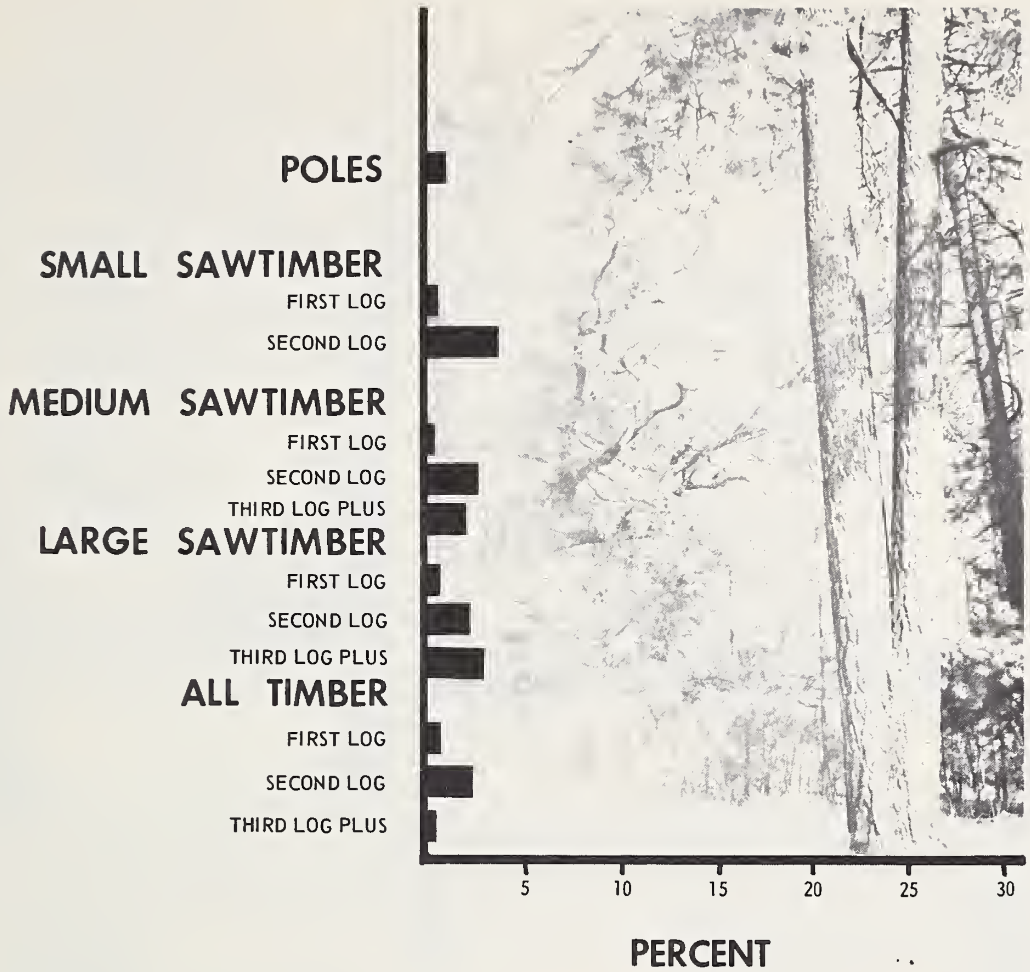

Figure 6.--Percentage of forked sample trees in four size classes.

recognized as secondary grading defects in determining timber quality for various products.

The two most common types of mechanical injuries in standing timber are basal scars, caused primarily by fire, and lightning scars. Basal scars in ponderosa pine are usually confined to the first half-log, whereas lightning scars often affect the entire merchantable stem. Lightning scars constitute a source of serious degrade, even when grown over, and are a major cause of mortality (Myers and Martin 1963, Wadsworth 1943). Dead and broken tops are also mechanical injuries primarily attributable to lightning.

The occurrence of basal and lightning scars, both more prevalent in larger trees, is indicated in figure 7. The occurrence of dead and broken tops in timber on the sample area is shown in figure 8.

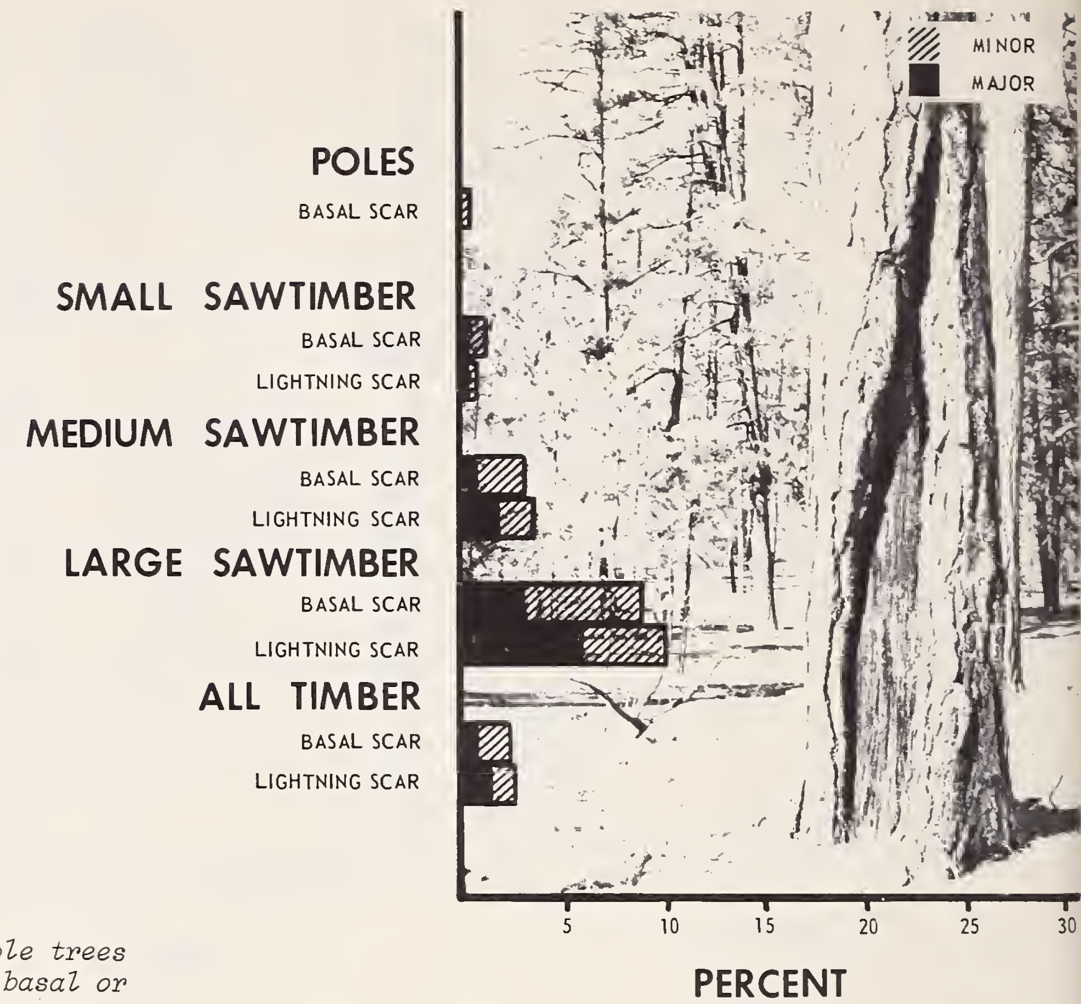

Figure 7.--Percentage of sample trees in four size classes with basal or lightning scars.

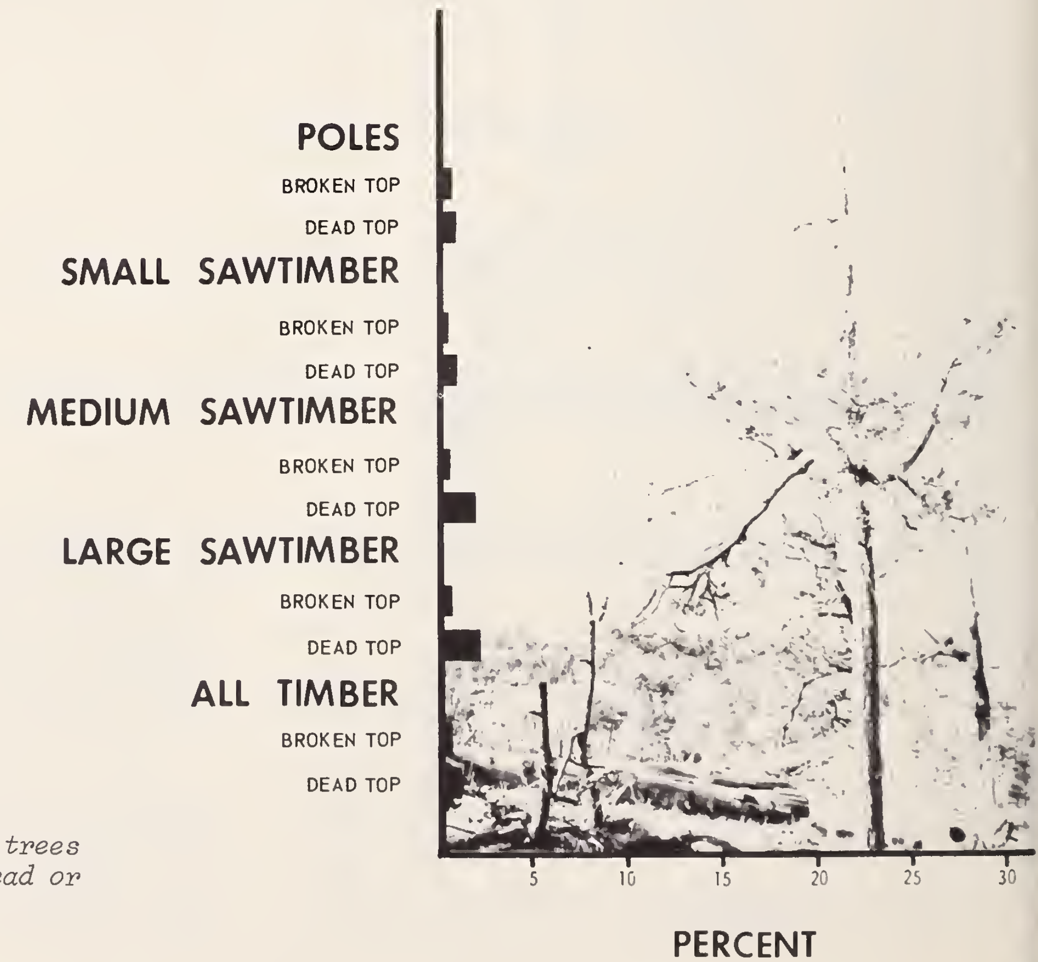

Figure 8.--Percentage of sample trees in four size classes with dead or broken tops.

Log Knot Configurations

The distribution of clear surface area, and the number and size of log knots are perhaps the most important stem features related to quality for most products. A knowledge of clear log surface and knot characteristics is essential to the evaluation of product potential in standing timber. The occurrence of clear 8-foot faces or panels in the butt 16-foot logs of sawtimber trees on the study area is illustrated in figure 9. Although occurrence was recorded for the first 32 feet of merchantable stem, practically all clear faces observed were contained in the first log.

The number and size of log knots in butt 16-foot logs of sawtimber trees are shown in figures 10 and 11, respectively.

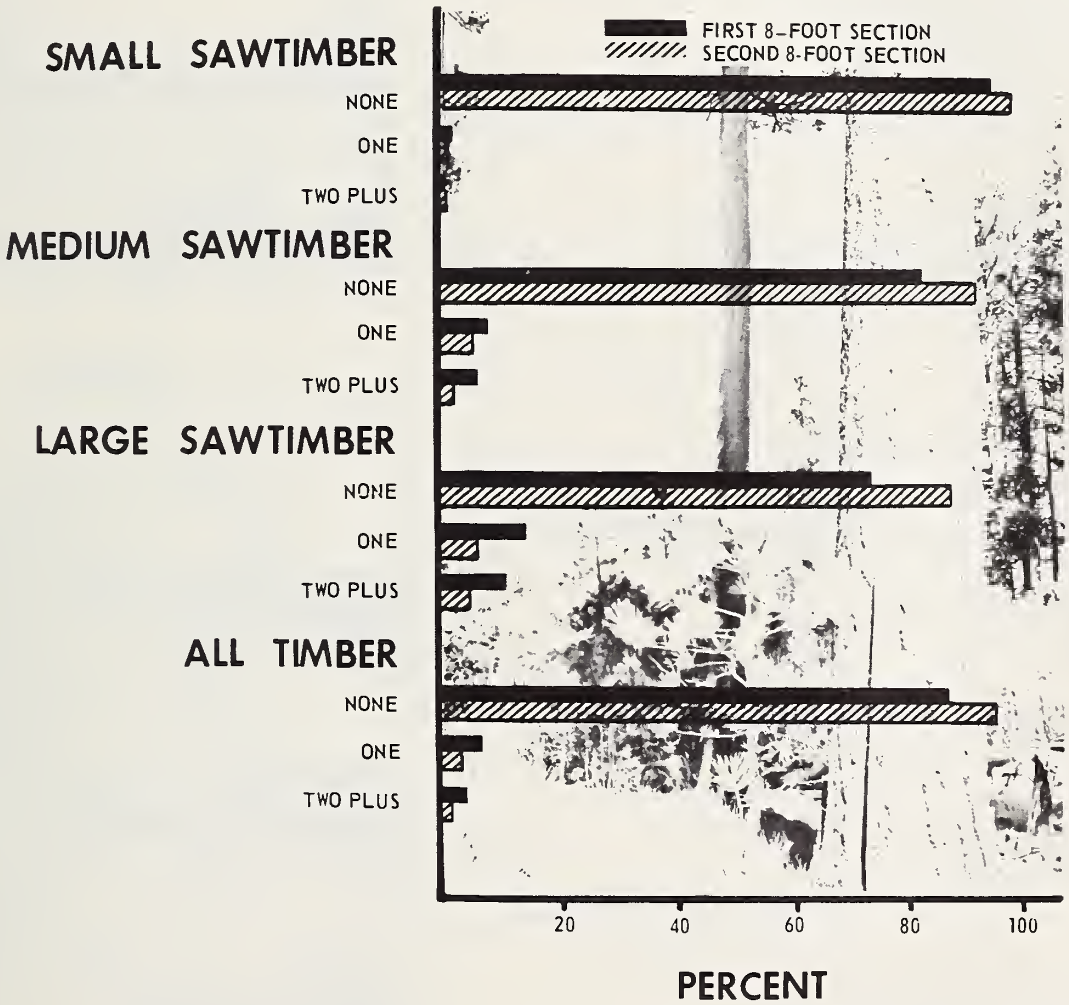

Figure 9.--Percentage of sawtimber stems having none, one, and two or more clear faces in the two lower 8-foot stem sections (first log).

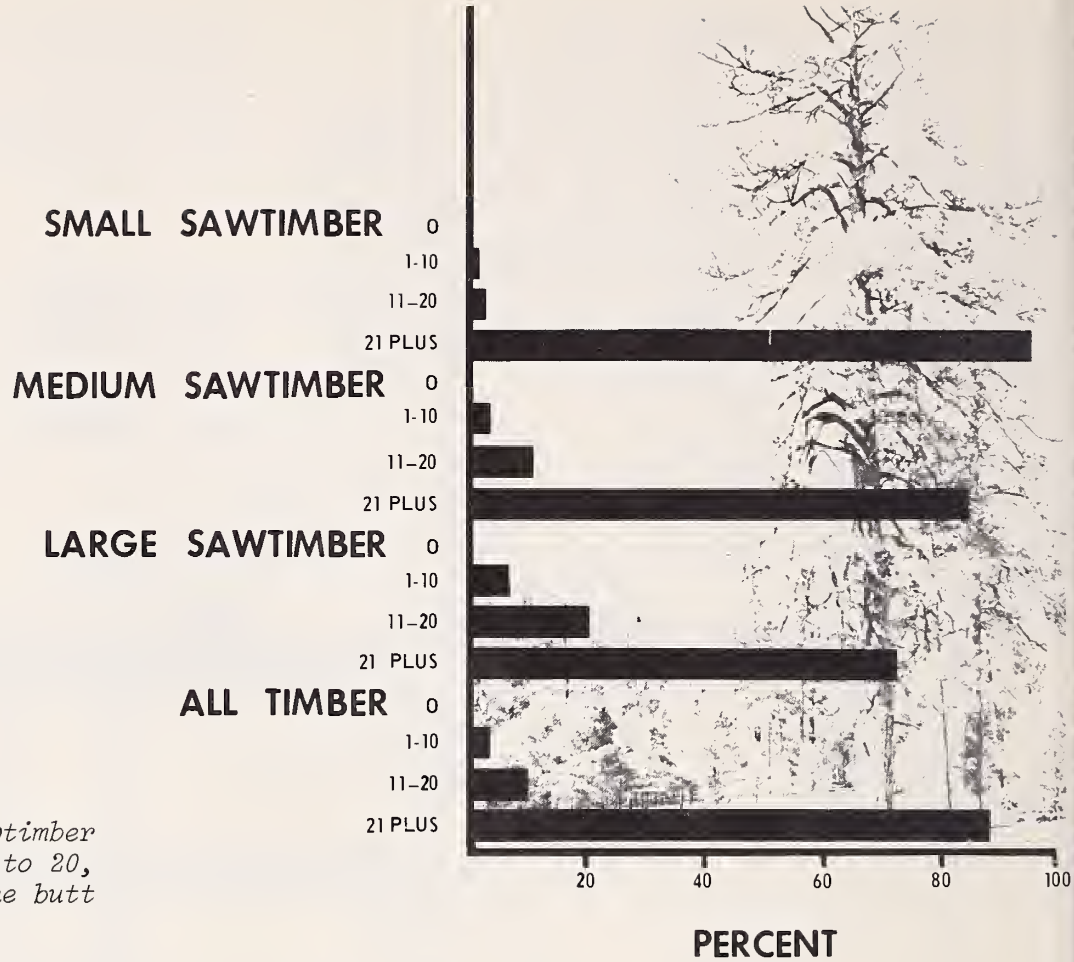

Figure 10.--Percentage of sawtimber stems having 0, 1 to 10, 11 to 20, and 21 or more knots in the butt 16-foot log.

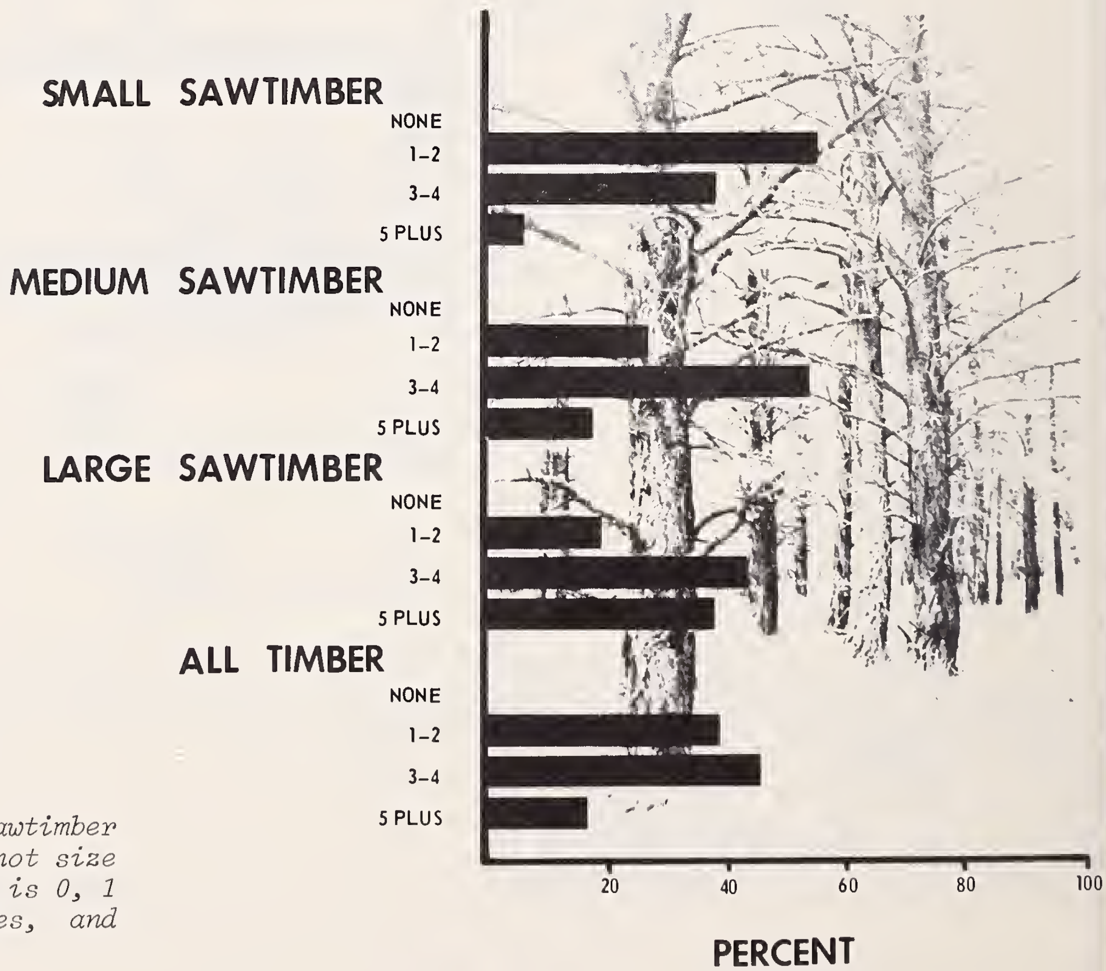

Figure 11.--Percentage of sawtimber stems in which maximum knot size in the butt 16-foot log is 0, 1 to 2 inches, 3 to 4 inches, and 5 inches or greater.

Potential Use of Quality Information

As utilization practices and consumer demands change, and the forest products industry adopts new products and processes, adequate timber utilization planning requires better resource information. Information describing the occurrence of fundamental stem-quality features provides an initial basis for interproduct comparisons and utilization decisions. The suitability of major timber types for a broad range of primary products can be appraised, and the extent to which particular stem defects will reduce product potential can be estimated.

In the Southwest, an increasing dependence upon cutover ponderosa pine necessitates closer examination of the quality of this resource. Data developed during this study are not necessarily representative of all cutover pine in the Southwest but they do indicate the general stem quality to be expected in cutover stands.

In the locale represented by the study area, current activity centers upon lumber (saw logs), commercial poles, and pulpwood. Interest is developing in plywood potential (veneer logs) and in chip or fiber panel product potential. Because the stem-quality features observed and recorded include the major grading and/or limiting criteria applicable to these and other primary products, suitability and range of quality of the resource for any particular product (Ffolliott and Barger 1965) can be reliably estimated. As interest in new products arises, and quality criteria change or develop accordingly, the stem-quality data provide a continuing basis for re-evaluation of resource potential.

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In the southwestern United States, most of the future timber resource is cutover ponderosa pine, and continued development and expansion of the timber industry depends on its quality. Data collected from 3,799 sample trees in northern Arizona on occurrence of visual stem features--sweep, crook, lean, fork, scars, and knots--provide a method for appraising suitability of major timber types for various products and to what extent stem defects reduce the product potential.

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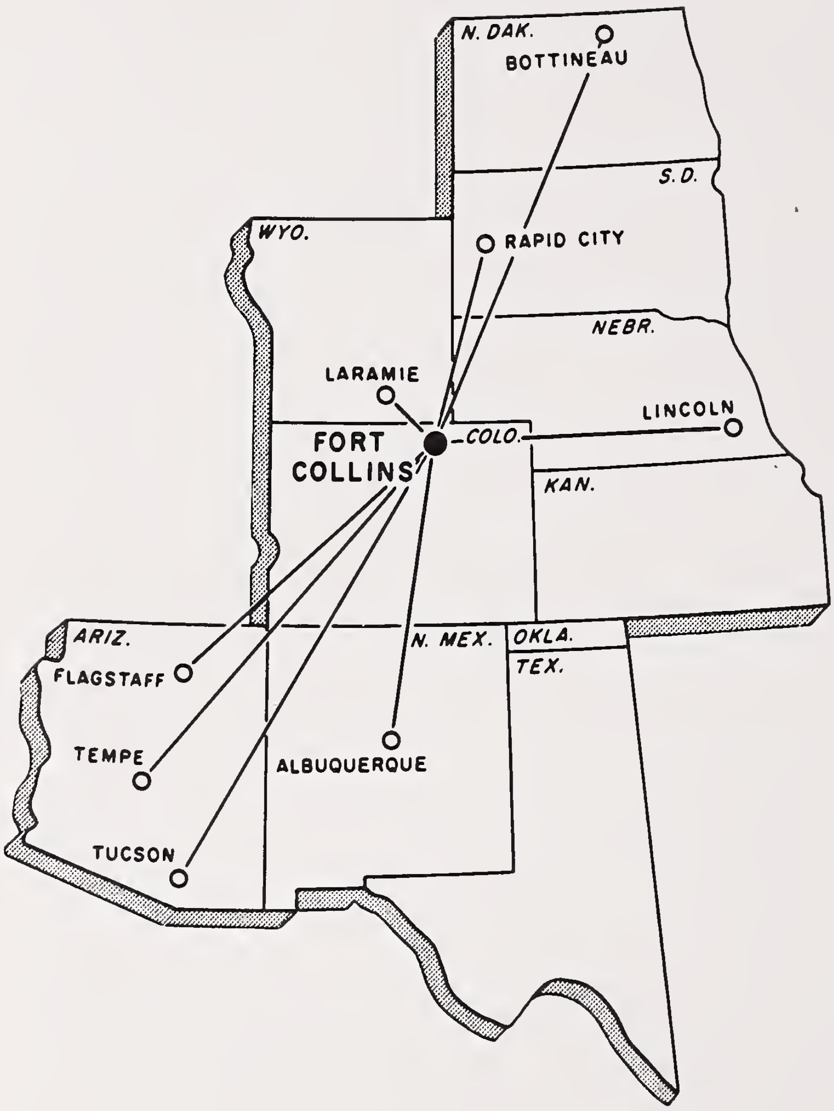

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